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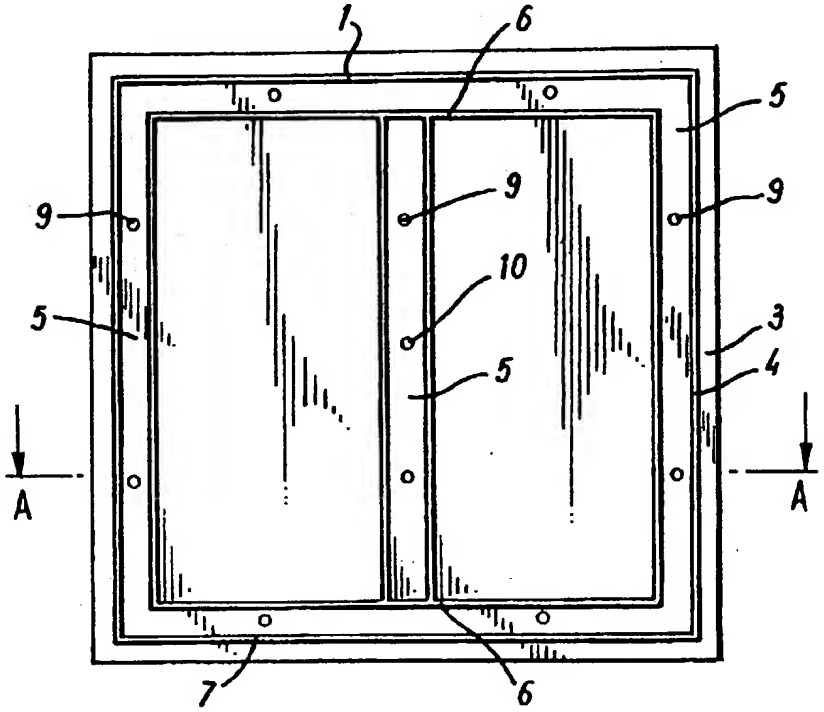
(54) Title: APPARATUS FOR AND A METHOD OF INJECTION MOULDING

(57) Abstract

Apparatus for injection moulding comprises two mould parts (1 and 2) defining a mould cavity. The cavity comprises a planar section (3) having pairs of parallel elongate ribs (4) disposed at intervals on one side of the section (3) and the central pair of ribs defines an elongate area (5) closed off at opposite ends by further ribs (6 and 7) thus producing two confined areas. Gas is fed to each via gas channel (8) each of which leads to a porous metal insert (9) on the surface of the mould cavity. Synthetic plastics material is fed to the mould cavity via a sprue and connected runners. During the moulding process after the injection and cooling of plastics material, gas is fed under pressure to the mould cavity via gas channel (8). This permits plastic in those areas to be pressurised and displaces plastics material to compensate for volumetric shrinkage of the plastics adjacent those areas. This in turn avoids sink marks.



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APPARATUS FOR AND A METHOD OF INJECTION MOULDING

The present invention relates to apparatus for and method of injection moulding.

There are many applications for injection moulded panels or structures in which it is desirable to create rigidity and dimensional stability, and at the same time to produce visible surfaces which are of a high quality without defects such as sink marks.

In order to create rigidity it is normally necessary to include ribs or webs on the underside of a planar section. It is often a problem resulting from this form of construction, particularly in the case of high shrinkage materials such as polypropylene, that sink marks or other unacceptable visual defects occur on the cosmetically important surface opposite the ribs and webs. There are also constraints on the design of the ribs or webs which normally have to be not more than two thirds the thickness of the planar section, because greater thickness would cause unacceptable sinkage on the visible surface. This restricts the strength or rigidity which can be designed into the structure without an unacceptable multiplicity of ribs or webs.

In such cases there is often a limitation on the height of the ribs or webs or overall thickness of the panel or structure for functional and

other design reasons. It is therefore desirable to include ribs or webs of greater thickness if this could be done without creating sink marks.

Attempts have been made to overcome the problem of sink marks by pressurising with gas the whole of the surface or a large portion of the surface of the underside of the structure between the ribs or webs. However this creates other problems resulting in uneven cooling of the two sides of the planar section, which leads to unacceptable distortion of the moulding. It is well known that if one side of a mould cavity is at a higher temperature than the other, the moulding will distort as a result of the differential cooling rate of the sides of the moulding. Likewise if there is an extensive area of a moulding where the gas causes a gap between the plastic surface and the adjacent mould cavity surface, the conduction of heat from the moulding will be slowed down and similar distortion will occur.

Another known method of including ribs or webs into a moulding and attempting to avoid sink marks on the opposite face of a planar section, is based on the injection of gas into the plastic so that a hollow section is formed at the base of the rib where it joins the planar section. This is achieved by the thickening of the rib at the base in order to attract the flow of gas into this section of the plastic, i.e. the gas flows the path of least resistance into the middle of the least viscous material, before the material has completely solidified during the cooling period of

the moulding cycle. However this method has not been successful in producing a visually perfect surface on a flat planar section opposite ribs due to differential shrinkage within the plastic of varying thickness.

It is an object of the invention to overcome or mitigate these problems.

According to one aspect of the present invention, there is provided apparatus for injection moulding comprising a mould having two parts which may be placed together to define a mould cavity, means for feeding synthetic plastics material to the mould cavity, means for feeding gas under pressure to the mould cavity at a position displaced from the means for feeding synthetic plastics material, the mould cavity being shaped to provide one or more ribs defining a sealed area within and substantially less than the area of the whole mould cavity and the means for feeding gas being operative to supply gas to the sealed area.

It is an important feature of the invention to prevent the leakage of gas from the mould cavity by totally surrounding the gas feed points with ribs or webs designed to form integrally moulded seals, thereby confining the gas to within the sealed area. This enables the pressure of the gas to be controlled from an external source.

According to another aspect of the present invention, there is

provided a method of injection moulding including the steps of feeding synthetic plastics material to a mould cavity defined by a mould having two parts, the mould cavity including one or more ribs defining a sealed area within and less than the area of the whole mould cavity, feeding gas under pressure to the sealed area at a position displaced from the means for feeding synthetic plastics material to pressurise plastics material in the mould, and exhausting the gas from the mould and opening the mould to remove the moulded product.

The invention also covers moulded articles made by the above apparatus or method.

As a further result of pressurising the surface of the plastic within the sealed area, some displacement of plastic within the section of the plastic and outwards from the sealed area occurs and compensates for the local volumetric shrinkage of the plastic which occurs during the cooling of the material, both within the sealed area and outside and adjacent to it. This contributes to the prevention of sink marks which occur when the plastic sinks back from the mould cavity surface during cooling.

In a preferred embodiment of the invention the article to be moulded comprises a table top or a bumper arrangement for a vehicle. Each article and the corresponding mould cavity comprise a planar

section behind or underneath which a plurality of pairs of elongate parallel ribs are disposed. The area between each pair of ribs is closed off at opposite ends respectively to produce a sealed area. The means for feeding gas comprise gas channels in one of the mould parts leading to respective sealed areas. At the head of each channel a sintered porous metal insert is disposed at the surface of the mould cavity.

In order that the invention may be more clearly understood, one embodiment thereof will now be described by way of example with reference to the accompanying drawings in which:-

Figure I shows a partial underplan view of a mould according to the invention,

Figure 2 shows a cross-sectional partial view along the line A-A of Figure I.

Figure 3 shows a modification of the mould of Figures I and 2,

Figure 4 shows the modification of Figure 3 after injection of gas, and

Figures 5 and 6 illustrate disadvantageous features of the prior art.

Referring to the drawings, the mould comprises two mould parts 1 and 2 defining a mould cavity. The mould cavity comprises a planar section 3 having pairs of parallel elongate ribs 4 disposed at intervals on one side of the section 3. The central pair of ribs defines an elongate area 5 closed off at opposite ends by further ribs 6 and 7. This closing off provides two confined areas within the mould cavity. Gas is fed to each of these confined areas via gas channels 8 each of which leads to a porous sintered metal insert 9 on the surface of the mould cavity. The porous metal insert permits passage of gas but prevents ingress of plastic. Thus in each confined area gas may be fed through these metal inserts. Synthetic plastics material is introduced into the mould via a sprue and connected runners in the usual way.

During the moulding process after the plastics material has been injected and is being allowed to cool gas is fed under pressure to the sealed areas 5. This permits the plastic in those areas to be pressurised and displaces plastics material to compensate for volumetric shrinkage of the plastic in close proximity to these areas. This in turn results in sink marks being avoided.

In order to allow for the displacement of plastic from within the sealed area in an embodiment of this invention the thickness of the planar section within the sealed area may be increased, so that after the displacement has taken place the thickness is closer to that of the

surrounding planar section thickness. Further it is desirable that the material thickness at the junction of the ribs and the planar section, and adjacent to the base of the ribs and within the pressurised sealed area, is increased by the inclusion of a fillet or radius which then allow for the flow of plastic and results in a change of shape to a smaller radius, but without forming an undercut or indentation at the base of the rib as illustrated. These features are shown before displacement in Figure 3. In this figure, the thicker planar section is shown at I5, the fillet at I6 and the radius at I7. The position after displacement is shown in Figure 4, the change of shape is a smaller radius being shown at I8 and the planar section having a thickness similar to that of the surrounding section at I9.

The apparatus and method provides the following advantages compared with the application of gas pressure over larger areas relative to the total:-

more uniform controllable exerted pressure

less adverse effect caused by a slow down of the cooling of the plastics material as a result of an air gap between the plastics and the mould cavity surface over a large area relative to the total planar area of the moulding.

ability to create more uniform pressure within the confined areas, particularly over three-dimensional curved surfaces where it would otherwise be impossible to create uniform pressurisation of the plastics.

the creation of sufficient strength in the structure by the inclusion of a pair of ribs or webs of thicknesses approximately one half of a single thicker rib 20 which would otherwise be required such as is shown in Figure 5.

by selecting rib thicknesses approximately equivalent to the planar wall section, more uniform material shrinkage occurs and therefore much reduced tendency for the moulding to distort after ejection from the mould.

the ability to pressurise the ribs at their base and section where they join the planar section, thereby preventing sinkage on the opposite cosmetic face of the structure.

the elimination of the need to provide and insert into the mould cavity surface relatively large porous metal inserts which would otherwise be required to conform with the shape of the mould surface. The use of smaller porous metal inserts normally round in plan view will enable the gas to flow across the surface within a limited sealed area and therefore be more effectively controlled. The use of comparatively

small porous inserts, typically of between 5 and 10mm in diameter, facilitates the injection of gas at multiple positions, thereby achieving a more uniform distribution of gas within one or more sealed areas and over flat or three-dimensionally curved surfaces.

and the avoidance of the need for ribs thickened at the base as shown at 21 in Figure 6 in order to provide paths of lesser resistance for internal gas under pressure.

It will be appreciated that the above embodiments have been described by way of example only and that many variations are possible without departing from the scope of the invention.

CLAIMS

1. Apparatus for injection moulding comprising a mould having two parts (1,2) which may be placed together to define a mould cavity, means for feeding synthetic plastics material to the mould cavity, means (8) for feeding gas under pressure to the mould cavity at a position displaced from the means for feeding synthetic plastics material, the mould cavity being shaped to provide one or more ribs (4) defining a sealed area within and substantially less than the area of the whole mould cavity and the means for feeding gas being operative to supply gas to the sealed area.

2. Apparatus as claimed in claim 1, in which there are two spaced ribs (4).

3. Apparatus as claimed in claim 2, in which the spaced ribs (4) are joined together at opposite ends by further ribs (6,7).

4. Apparatus as claimed in any preceding claim, in which means (8) for feeding gas comprises at least one gas channel.

5. Apparatus as claimed in claim 5, in which the or each gas channel (8) leads to a porous metal insert (9) disposed on the surface of the mould cavity.

6. Apparatus as claimed in any preceding claim, in which the mould cavity is shaped to provide a fillet (16) or radius (17) at the base of the or each rib (4) to offset any tendency for an undercut or indentation to be formed at the base of the rib (4) during moulding.

7. Apparatus as claimed in any preceding claim, in which the mould cavity is shaped to provide a section of greater thickness within the sealed area than outside it.

8. A method of injection moulding including the steps of feeding synthetic plastics material to a mould cavity defined by a mould having two parts, the mould cavity including one or more ribs defining a sealed area within and less than the area of the whole mould cavity, feeding gas under pressure to the sealed area at a position displaced from the means for feeding synthetic plastics material to pressurise plastics material in the mould, and exhausting the gas from the mould and opening the mould to remove the moulded product.

9. A moulded product made by the method of claim 8.

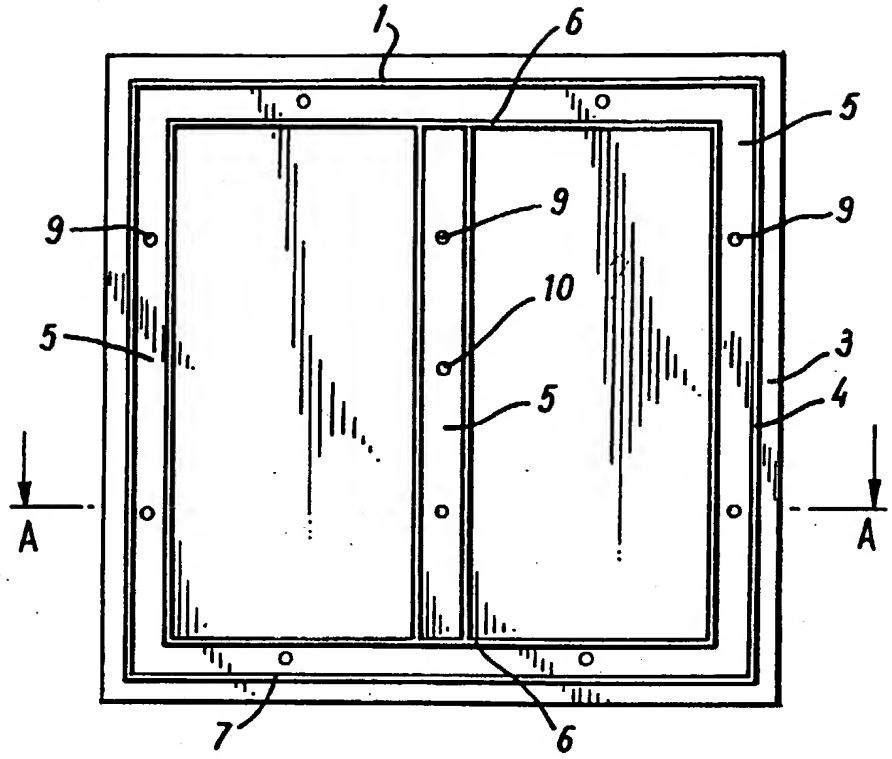

FIG.1

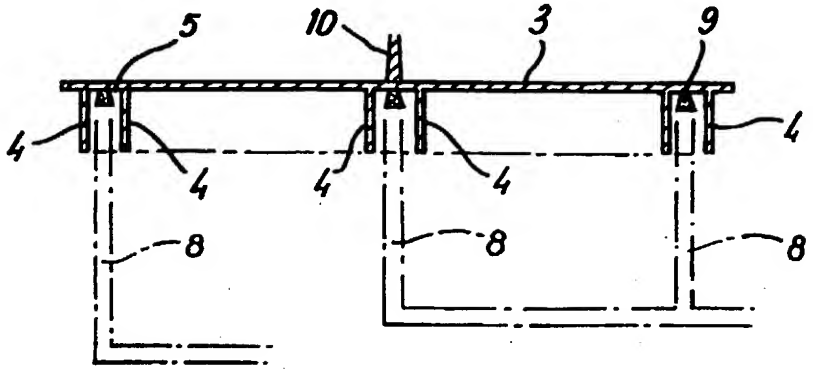

FIG.2

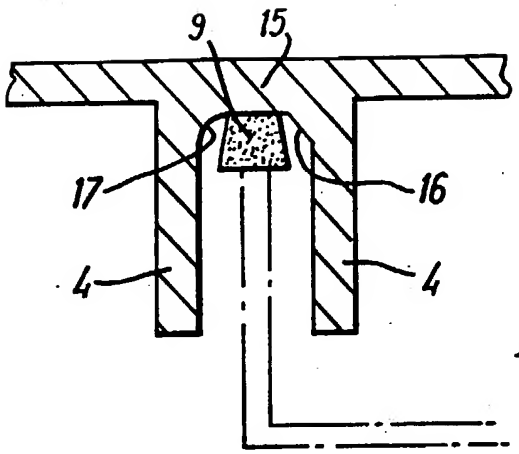

FIG.3

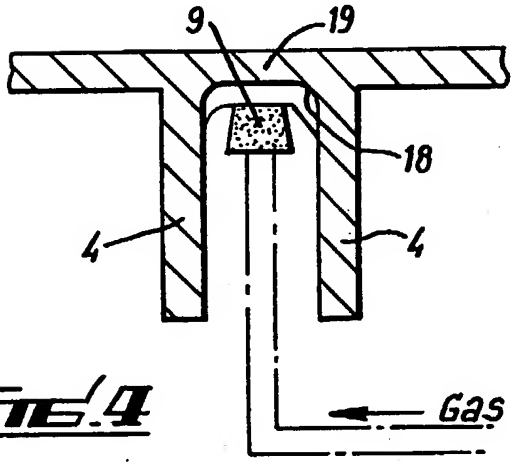

FIG.4

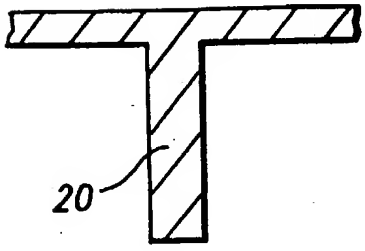

FIG.5

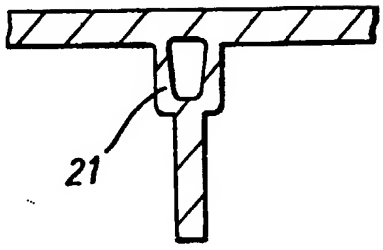

FIG.6

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 94/00613

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 B29C45/17

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO,A,93 14918 (HAYWOOD HOLDINGS) 5 August 1993 see page 21, paragraph 3 - page 22, paragraph 2; figures 8A-9C	1-5,7-9
X	PATENT ABSTRACTS OF JAPAN vol. 9, no. 94 (M-374) (1817) 24 April 1985 & JP,A,59 220 337 (ICHIKO KOGYO) 11 December 1984 see abstract	1,4,8,9
X	WO,A,90 06220 (CARROLL) 14 June 1990 see the whole document	1,4,5,8, 9

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Date of the actual completion of the international search	Date of mailing of the international search report
3 August 1994	18.08.94

Name and mailing address of the ISA	Authorized officer
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information on patent family members

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WO-A-9314918	05-08-93	NONE		
WO-A-9006220	14-06-90	AU-B-	635235	18-03-93
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		EP-A-	0400135	05-12-90
		JP-T-	4501090	27-02-92
		US-A-	5273707	28-12-93